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TITLE OF THE INVENTION

BOOM VANG WITH BOM VANG BRACKETS FOR A SAILING VESSEL

CROSS REFERENCE TO RELATED APPLICATIONS

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STATEMENT REGARDING FEDERALLY SPONSORED RESAERCH OR DEVELOPMENT

Not Applicable

REFERENCE TO SEQUENCE LISTING, A TABLE, OR A COMPUTER PROGRAM LISTING, ..

Not Applicable

SPECIFICATION

BACKGROUND OF THE INVENTION

This invention relates to a rigid boom vang with adjustable fittings for a sailing vessel.

Typically, a sailboat boom extends at an approximate right angle to the vertical mast is connected to the mast by a gooseneck with a toggle and a swivel joint, allowing the boom to swing horizontally and being lowered or raised at the rear end. Without a rigid vang and with sails down the boom is held by a topping lift fitted to the vessel. With raised sails the boom is held upward by the main sail. Especially when sailing downwind or on a reach, air pressure against the mainsail forces it to bulge and causes the end of the boom to rise.

So a vang, an adjustable device or mechanism secured between the forward portion of the mainsail boom and a location near the base of the mast is used to keep the boom under control. Until a few years ago typical boom vangs were line-purchase systems, distinct from that of the main-sheet, including two or more blocks or pulleys attached to the boom, and a single line having one end secured to one of the pulley systems, with the line having a free end which is pulled out and released manually by the sailor.

To support the boom while the main sail is down and therefore eliminating the topping lift, or to counterbalance the boom in very light wind conditions to maintain an optimum shape of the sail, these line-purchase systems were then supplemented by a mechanical vang. Whereas the line-purchase system could only apply pulling force, the mechanical vang, consisting of a telescopic strut with two tubular members connected by a spring, applied, when retracted, lifting force to the boom. However, this means that the spring force must be overcome in order to trim the sail.

There are also hydraulic driven boom vangs in use, but these systems, due to price, weight and complexity are generally found only on bigger yachts.

Upcoming modern sailing cloth of high strength and precise computer aided design require more precise sail trim to be efficient than with the traditional materials. Also, there is a tendency lately to control the heel of sailing boats rather by trimming the trailing edge (leech) of the sail, than with the main sheet. This new technique, called VANG SHEETING allows by altering the height of the rear end of the boom to tighten or release the leech of the sail (adding twist), thus controlling airflow in the upper third of the sail where wind and heeling force are strongest. The use of the vang enables the mainsail to be flattened independently of mainsheet tension and as the wind increases to depower the mainsail to control heel.
As pointed out, modern sailing cloth and the growing awareness to efficiently exploit the natural power of wind has led to the use of rigid vangs rather as trimming devices than just to keep the boom under control. It is obvious that fine tuning the boom works best the more power one could apply to it. In traditional systems this could be achieved by applying more blocks or pulleys. The disadvantages then are the need for long lines, loss of efficiency due to friction, the need for strong springs which have to be overcome when handling the boom vang. Further, the complete system from the boom fitting to the line stopper in the cockpit is under constant strain. A good ratio for the line-purchase system would be 8:1. Assuming a manual pulling power of 50 kg and a loss due to friction of 25% would result in a pulling force of 300 kg, the effective vertical part of this force applied to the boom at this point would then be only 212 kg. The operative downward force to the sail leech with a typical length ratio from mast to boom vang fitting to the overall boom length of 4:1 would leave only something more than 50 kg. This is little for precise trimming even in moderate winds.

Another matter of importance fitting a boom vang is that the vertical pin bolt of the boom vang bracket near the mast base must be parallel to this part of the mast and needs to be aligned with the vertical gooseneck pin, to ensure a correct horizontal movement of the boom.
The distance from the mast to the spin axis of the gooseneck pin is not standardised and different mast profiles require different fittings. Therefore, often the entire rig including mast, boom, boom vang etc. has to be purchased from one vendor, leaving no choice for more favourable solutions.

See also:

Literature:

"Use of vang enables the mainsail to be flattened independently of mainsheet tension, and it is the most effective of all controls for dynamic tuning." "As the windspeed increases in each gust, in flat water we use the vang as the primary control to flatten and depower the mainsail on a gust by gust basis."

Frank Bethwaite "High Performance Sailing" Pp. 222/294

Internet:

Links to Vang Sheeting

http://life-marine.de/html/Links_Vangsheeting.htm

BRIEF SUMMARY OF THE INVENTION

The present invention comprises a telescopic rigid boom vang as trimming device for sailboats with a combined hand/line drum and adjustable vang brackets.

The boom vang consists of a center part and two symmetrical outer extensions with one of them fixed to the boom the other to the mastbase. The center part is a threaded rod having a left-hand and a right-hand thread portion of the same length, which are either connected by a flange, sleeve, screw bolt or other connector. A left-hand thread is a thread that when viewed axially (from the end) winds in an anticlockwise direction. A combined hand- and rope-drum unit for turning the connected rods either by hand or rope is attached where the two threaded rods are connecting. At one end each rod is threaded to a tubular device containing a round drive nut on one end and a matching mounting device, like a clevis with or without an adapting collar on the outer end. To keep the extension tubes aligned each rod carries a disk bearing at the outer end which fits into the extension tube so when the tubes are threaded on the rods they remain in line. For safety and added stability the rods and that part of the extension tube which is threaded will be enclosed in an outer tube, approximately the same length as the the rods, with an inner sleeve bearing at the end thus supporting the inside extension tubes. The enclosing tube is fixed centrally to the drum, therefore this tube may consist of one or two parts, depending on how they are fixed to the drum with the rods. Turning the wheel drum either by hand or preferably by single continuous loop of line running round the drum and back to the cockpit will move the extension tubes symmetrically and apply movement between the clevis and the boom & mast.

The advantages of the described boom vang compared to line pulley systems with a spring are, that it applies more power, that the power can be metered precisely and that the thread drive is safer and more convenient to use. A linear drive with threaded rod has less friction and a much greater purchase than having long lines running around several blocks and pulleys as in common boom vang systems. Tests with the described boom vang have shown that one could apply effectively more than 3 times pulling power and there is no counterforce to overcome as in spring loaded models.

Although the arrangement having the rods fixed to the central part is the preferred one, an alternative layout would house the rods within the extension arms, fixed at their ends and having the drive nuts mounted in the outer arms of the central unit. Then the tubes of the extension arms would enclose the tubes of the central unit, which would be less favourable.
Using a construction with one thread rod would double the force but would also require twice as many rotations of the wheel for the same extension, thus degrading quick handling.
Properly installed at an angle of 45° to the mast, due to the symmetrical movement provided by the contrary handed rods, the lines leaving the drum will always point to the gooseneck, no matter how extended the arms of the boom vang are. So, running the drum line to a turning block near the gooseneck and from there via a mast base turning block to the cockpit would be possible without altering position or length of the line while shifting the boom.
The power and the amount of extension can be applied very precisely and directly, one turn of the drum will extend the boom a defined length without slip or stretch as in common systems where all lines are under constant strain. All tensions are kept within the system because the chosen threads are self locking .
A continuous loop of line to drive the boom is convenient to use because it avoids cluttering lines. For proper operation the line drum must engage the loose line from various positions, without having to straighten the line from the other end. This is achieved by running the line inside the drum through a system of rollers and v-formed grips.
One of the most dangerous tasks for a sailor is packing the sails either for reefing or storing the sails to the boom, because this cannot be done with one hand (and the other for the boat). So usually the sailor leans the upper body upon or against the boom which is then usually horizontally fixed by the mainsheet and grabs the sail cloth with both arms to bind it to the boom. This only can be done safely when the boom, under the body's weight, doesn't move downward, which is often the case with spring loaded systems. So the inherent self locking ability of the thread driven systems adds important safety, specially in rough sea when the boat is in a rolling movement.

The present invention comprises additionally adjustable vang attachment brackets to a sailboat mast and boom.

Numerous forms and sizes of masts and booms would need many different shaped brackets to mount a boom vang. This and the necessity to align the axis of the boom vang mast bracket bolt to that of the vertical boom gooseneck pin to maintain an even horizontal movement of the boom around the mast has led to the invention of an adjustable vang bracket which can be attached to flat or cylindrical shaped surfaces and having an adjustable vertical toggle pin axis.

This is achieved with a hinged joint system consisting of two identical base brackets, to which a toggle or two more hinged arms with a toggle could be mounted. In contrary to a vang mast's toggle a boom bracket's toggle can be left in a fixed position to the boom. So the boom vang bracket incorporates only two identical base hinges with the holes for rivets, screws or a T-notch boom plate. One base hinge turned 180° fits into the other and the toggle can be inserted between them on the common bolt. The connecting pin of the vang clevis mounted on the toggle allows the boom to vertically swing around the gooseneck's horizontal pin.

A boom vang mast bracket then consists of two base hinges as described before, complemented with two other hinged arms, again of identical shape but one of them turned 180°, to fit into the other and carrying a toggle on their connecting bolt. This arrangement then permits a boom vang mast bracket's toggle to turn around its axis more than 180°, whenever this is needed to follow the boom's movement. The bracket's base aligns itself to the angle of the holding ground because it can turn around its axis. The hinged bracket base plates have a concave surface on the underside that will ensure a continuous contact along their sides to any flat or cylindrical surface as long as that radius is bigger than the concave radius of the base brackets.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is a diagram showing, in part section, a vang, in accordance with the invention, and its connections to main-boom and main-mast of a yacht. An extended vang is shown with broken lines. FIG. 1 is supposed to be the frontpage view;

FIG. 2 is a diagram showing a view of a left hand and a right hand thread rod connected by a central flange and having disc bearings at the outer ends;

FIG. 3 is combined hand/rope drum with cylindrical fitting, consisting of a symmetrical pair , with a grip and a roller cage between the halves;

FIG. 4 is a section view of a set of two enclosing tubes with sleeve bearings on each outside end;

FIG. 5 is a sectional view of the center part as an assembly of FIG. 2, FIG. 3 and FIG. 4;

FIG. 6 is a sectional view of an extension tube with a left hand driving nut on the inside end;

FIG. 7 is a sectional view of an extension tube with a right hand driving nut on the inside end;

FIG. 8 is a cross-section view of an assembled thread driven boom vang;

FIG. 9 is an enlarged sectional view of the left end of the enclosing tube with a sleeve bearing of the central unit and the left end of a thread rod with a disc bearing attached.

FIG. 10 is an enlarged sectional view of the center part of the hand- rope-drum, showing the rods, connected through the center flange, the drum connected to the flange by screws and the enclosing tubes connected to the drum.

FIG. 11 is an enlarged sectional view of a thread rod running through a drive nut which is kept centered by its flange to the inner wall of the enclosing tube.

FIG. 12 is a frontal view of the combined hand / rope drum with one half of the drum removed to show a rope running between radial grips and a roller cage with arrows to indicate their movements;

FIG. 13 is a plane sectional view of two identical base brackets one turned 180° with fixing holes and hinge bearings for a vang fitting;

FIG. 14 shows a sectional view of toggle with a vertical bolt hole and a horizontal pin hole;

FIG. 15 is a view of two assembled base brackets as in FIG. 13 connected by a bolt, with a toggle attached;

FIG. 16 is a frontal view of FIG. 15 attached to a boom profile;

FIG. 17 is a sectional view of two identical hinges one turned 180°;

FIG. 18 is a view of a vang mast fitting with two base brackets, two hinges and a toggle;

FIG. 19 is a topside view of a vang mast fitting with two base hinges close together;

FIG. 20 is a topside view of a vang mast fitting with two base hinges at maximum distance to each other on a mast profile;

FIG. 21 is a view of prefabricated profils for base hinges and hinge arms, rotary grinded and cut to different brackets;

DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

A rigid vang **1** according to this description fitted to a boom **2** and a mast **3** is shown in **FIG.1**. If properly installed in a 45° position to the horizontal boom and the vang mast bracket pin **4** aligned to the vertical gooseneck **5** pin, the operating line **6** leaving the drum **7** with a 90° angle to its turn axis, always points to the gooseneck **8** , regardless of the boom vang extension, as it is shown by a dotted line with an extended vang **9**. From two sheave blocks **10**, one on each side of the gooseneck the lines run down to a turning block **11** at the foot of the mast and from there to the cockpit. This is a preferable line operating layout, because it avoids cluttering, as might occur if the lines were leading directly from the boom vang drum to the cockpit.

The most distinctive part of the boom vang is shown in **FIG. 2**. A left-hand **12** and a right hand **13** threaded rod are face side connected to a flange **14**. The connection could be arranged by various methods, here it is assumed that a cylindrical lathed part **15** of one rod end fits through a center hole of the flange **14** into a matching cylindrical hole of the other rod end and that all parts are welded, soldered or brazed together **FIG. 10**. That way the inner sides of a combined hand/rope drum consisting of two halves, are mounted to both sides of the flange **14**, enclosing it and held together by a releasable connection as by bolts **17**, either to the flange or through punches in the flange to the corresponding half drum part.

Two enclosing tubes **18/19** which are pressed, bonded or by any other appropriate way fixed to the cylindrical parts **20** of the drum halves will complete the center part **21** of the boom vang leaving the line mechanism **22** inside the drum for later explanation.

The center part of the boom vang **FIG. 5** will house the extension tubes **23/24** which will enclose the threaded rods **12/13** by corresponding drive nuts **25/26** and are, depending on the position of the drive nuts on the rods, partly enclosed by the outer tubes **18/19**. To keep the rods centered, disks **27** are added at each rod end, acting as bearings to the inner walls of the extension tubes **23/24**, whereas the enclosing outer tube ends of the center part will house bushings **28** to guide them. The extension tubes are threaded to the rods, one by a left hand nut **25** and the other by a right hand nut **26**. These nuts could be machined directly into the tubes **23/24**, but a favourable solution as shown in **FIG. 10** is to bolt or bond them as separate items into the tube ends.

To add more stability and to keep the extension tubes fixed to the drive nuts under heavy pressure the drive nuts have collar flanges **29** which will also guide the extension tubes through the enclosing outer tubes. Thus the extension tubes are well supported to the rods and the enclosing tubes by the thread of the drive nuts **25/26**, the disks **27** at the end of the rods, by the flange shoulders **29** of the drive nuts **25/26** and the bushings **28** at the outer enclosing tubes. Turning the drum, with the clevis ends **30** of the extension arms fixed to the vang mast **31** and vang boom fittings **32** will symmetrical move the extension arms out or in, heaving or lowering the boom around the gooseneck's horizontal pin **16**. In this description the threaded rods are preferably mounted centrally to a flange, but the same principle could be applied by having two rods fixed inside the extension arms and having the drive nuts fitted to the outer ends of the central part **21**. Then the outer arms **23/24** would enclose the tubes **18/19** of the central part. Because these threads are self locking on the drive nuts **25/26**, the unit could be used as described until now without lines by turning the drum manually. However, most commonly the boom vang will be operated from the cockpit. Therefore the drum will have an internal system of rollers **33** and V-shaped grips **34** to engage the incoming line **35** to the drum **7** even when the pulled outgoing line doesn't have any counter force on the feeding side in order to straighten the line and get grip to the drum. So the feeding end of the rope may hang loose.

FIG.12 shows a frontal view of the inside of a drum-half with a rope **35**, rollers **33** with their pins **36**, v-shaped grips **34** and a movable cage **37** with pin holes to keep rollers and pins fixed at their relative position. The rectangular plates **34** with a V-shaped inner contour with sharp edges called grips **32**, are fitted into corresponding centric slots **38** inside each drum half, thus connecting and positioning the two drum parts to each other. An outer centric groove **39** of each drum half carries a semi-circular plate, called here cage-plate **37**, with holes for roller pins **40** and another groove **41** that keeps the roller pins in a circular position. Between the two cage-plates rollers **33** are mounted, held by pins **40** whose ends are free to circulate in their groove. When the drum halves are bolted to their corresponding tapping holes **42** or to the flange **14**, the cage unit **22** with the rollers can freely circularte around the thread rod axis **43** inside the drum.

The vang sheet's operating line **6** is fed between the V-shaped grip plates **34** and the rollers **33**; in case of an infinite loop the drum halves have to be dismantled to position the line between

the grip plates and the rollers. Pulling the line on one end will straighten the line inside the drum, pressing it into the v-shaped cutout and jamming it there, thus applying torque and turning the drum. The rollers of the cage will press the line into the V-shaped cutouts and prevent it from falling out if the line is hanging headover, having no tension at the incoming side. The rollers **33** at the end **44** of the semicircular cage will ease the feed of the line into and out of the drum. The cage with the rollers will circle only a limited way until the tension force of the pulling line will prevent this movement, but the drum itself will move against the cage when the drum is turned. To adjust the rope drum to different kind and sizes of ropes, the V-grips **32** are plugged into their radial slots **45** and can be changed like the rollers to fit different shapes and sizes and rope materials.
This principle of rope-drum operation with a moving line cage might also be used for other gear like backstay adjusters or sail furlers on sailboats.

The invention describes further a bracket system developed predominantly for boom vang fittings at the mast and boom **31/32**, but which can be used also for every kind of mounting brackets, as for radar domes or antennas on flat or cylindrical shaped surfaces.
To provide a clean function of a boom vang, the axis of its horizontal turning point, which is the vertical pin of its vang mast bracket **4** must be aligned with that of the boom, which is the vertical pin **5** of the gooseneck bracket **8**. If not, the two different radius, one, which is the horizontal part of the length of a mounted boom vang **1**, and the other that of the boom's turning axis at the gooseneck pin **5** to the vangs boom connecting bolt **46**, would result in an up or down movement of the boom's outboard end while being turned.
This problem will be solved by a bracket consisting of a hinge system where one of the hinge bolts carries a toggle **47** on which the clevis end **30** of a rigid boom vang can be mounted. The basic form of a boom vang bracket consists of two identical base hinge plates **48** with a concave underside and holes **49** for bolts or rivets. The underside **50** of these base hinges will be in continuous contact with their lengthwise edges **51** on surfaces as long as their concave-radius remains smaller than that of the holding ground **52**. Rotated by 180° one of the identical hinges fits the other connected by a common bolt **53**, leaving space for a toggle **47** on the same bolt.

Having the freedom to rotate around the common bolt **53** the basic plates **48** can adjust to different cylindrical surfaces **52** as found on different booms. Adding another hinge arm **54** to each base bracket will give a double hinge which then can carry more hinges or a toggle on the common axis **55** of both added arms. Again these additional hinge arms are of identical shape, one of them turned around 180° will fit into the other leaving space on the common axis to fit a toggle. Changing the distance of the the base plates **48** being apart **56** alters the angle between the added hinge arms **54** and thus determines the distance **57** of their common bolt together with that of the toggle axis to the mast surface **58**. This way it is possible to align the boom vang mast bracket pin to that of the gooseneck's vertical pin. Using identical basic parts for the mast and the boom fitting and using same parts turned 180° for both sides of the hinge is very economical to produce these brackets. Long strips of prefabricated profiles **59** with holes can be used for different length of hinges. As the holding power of the brackets is dependent on the number of connecting rivets or bolts to the surface, different lengths of hinges with resulting numbers of holes will provide different brackets of different strength. **FIG. 21** shows that by determining the length and the cutting width **60** of rotary grinding from the prefabricated strips, produces a family of different brackets. Another advantage is that changing a smaller bracket for a stronger one will require only the additional new holes in sensitive rig equipment.